5. RELIABILITY OF THE BARANGAY-BASED SMALLHOLDER TREE FARM INVENTORY: RESEARCH AND POLICY IMPLICATIONS

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The reliability of the inventories of smallholder tree farms conducted by barangay chairmen in selected municipalities in Leyte has been evaluated. The average number of trees per farm reported in the barangay-based inventory is 40 while the average verified number of trees is 49. The average stand age reported is 9.25 while the verified stand age is 9.03. No significant difference was found between the barangay-based inventory and verified data in terms of number of trees and stand age. Regression analysis shows that the difference in number of trees reported and the verified number of trees is directly proportional to the aggregate number of trees grown, thus the more trees grown, the higher the difference. The species reported by barangay-chairmen were found to be correct although some of them were reported using local names. The response rate of barangay chairmen in conducting the barangay-based inventory was acceptably high.

INTRODUCTION

A study to evaluate the reliability of a barangay-based inventory of smallholder tree farms has been conducted as part of the ACIAR Tree Farm Project[1]. Findings of this study were reported by Cedamon (2007) and Cedamon *et al.* (2007). The data from this study have been revisited, and the data set for an analysis of the number of trees has been refined. Key issues discussed in this paper are the following: first, 'how reliable is the number of trees and stand age in the barangay-based inventory of smallholder tree farms?'; second, what are the strategies employed by barangay chairmen in collecting tree farm data for the barangay-based inventory and which method has the highest reliability?; and third, does the size of tree farms, expressed in terms of number of trees, affect the reliability of the barangay-based inventory? In addition, the implications of the reliability of the barangay-based inventory for future research as well as for policy-making are discussed.

A background of the evaluation study is provided in the next section. The rationale of the barangay-based inventory is discussed in relation to providing information for smallholder tree farms and to wider scale tree resources outside forests (TOF). Results of the revised analysis of the reliability of the barangay-based inventory in terms of number of trees and stand age are presented. The implication of the reliability of the barangay-based inventory for supply analysis is discussed. Finally, the potential role of barangay chairmen in taking part in tree registration and the potential and prospects of the barangay-based inventory for developing market information and farm forestry accounting systems are examined.

[1] The ACIAR Smallholder Forestry Project is a collaborative research project of the University of Queensland, Visayas State University and the Department of Environment and Natural Resources titled '*Improving financial returns to smallholder tree farms in the Philippines*' ACIAR Project No. ASEM/2003/052.

BACKGROUND OF THE EVALUATION STUDY

In the ACIAR Tree Farm Project a sample of tree farms in Leyte Island was required for a timber inventory and assessment of forestry attitudes and practices of tree farm owners. A series of discussions were held during the project planning workshop in February 2005 to design a strategy to sample tree farms for the various studies of the project (see Herbohn *et al.* 2005 for details). A multi-stage sampling was identified during the workshop as the appropriate technique for selecting sample tree farms which would involve selecting municipalities at the first stage and selecting barangays at the second stage. Because selection of municipalities and barangays should be done with Geographic Information System (GIS) technology, a two-stage sampling has not been realized due to the unavailability of GIS shape files of the barangays. Instead, a single-stage probability proportional to size (PPS) sampling was employed in selecting seven sample municipalities (see Baynes *et al.* 2007 for details). As a consequence, information relating to tree farms within the selected municipalities was required for the selection of sample tree farms. In May 2005, a meeting with municipal officials and barangay chairmen of one of the selected municipalities was organized by staff of the ACIAR Tree Farm Project to discuss possibilities of getting tree farm information from the barangays. During the meeting, the municipal officials and barangay chairmen were asked if they could assist the project in identifying tree farmers in their municipality. The barangay chairmen agreed to provide data of tree farms in their barangays. The project staff provided the barangay chairmen with the list of data required and they were briefed about the exact information required. The tree farm data from the barangays were submitted by barangay chairmen to the Municipal Agriculture Officer two weeks after the meeting. The data obtained from the barangay chairmen included the names and home addresses of tree farmers. For each tree farm, the location (sitio or zone) of the farm parcel, species of trees planted, the number of trees planted, and planting pattern were reported. Because the collection of tree farm data by barangay chairmen was found to be feasible, the same activity took place in the other six sample municipalities in August and September 2005. The tree farm data collated by the ACIAR Tree Farm Project were then used in selecting tree farms for a timber inventory (Bernaldez *et al*. 2007) and the subsequent socio-economic survey of smallholder tree farmers.

During January to March 2006 the reliability of the barangay chairmen data (referred to here as the barangay-based inventory) on the tree farms was evaluated. The evaluation was conducted as a research project by the first author leading to his Master of Science in Forestry degree at Visayas State University. The evaluation study was aimed at determining the reliability of the barangay-based inventories conducted by the barangay chairmen in the sample municipalities included in the ACIAR project. Sample tree farming households were selected through cluster sampling in which tree farmers were clustered according to barangays. Ten out of 108 barangays in the seven municipalities were randomly selected for the evaluation study which gave a sample of 115 tree farming households. The selected barangays[2] included Barangay Bugasong in Libagon Municipality, Southern Leyte; Barangays Anahawan, Alejos, Amagos and Ponong of Bato Municipality, Leyte; Barangay San Vicente in Hindang Municipality; Barangay Apale in Isabel Municipality, and Barangay Tapul, Kawayan and Consuegra in Leyte Municipality, Leyte.

The chairmen of the selected barangays were informed by the researcher about the evaluation study and permission and cooperation[3] to conduct the study were obtained from them. Field verification was conducted for each reported tree farming household. During field

[2] In subsequent sections, the names of barangays are not reported to retain the confidentiality of barangay chairmen.

[3] In all barangays, the chairmen provided a barangay council member or barangay tanod to assist the researcher to find the reported tree farmers. The council members and tanods who assisted the researcher as guides were paid PhP200 per day.

verification, the trees were counted, the planting pattern and species of trees were recorded on a tree farm data sheet, and tree farm owners were interviewed to determine the planting year. Barangay chairmen of selected barangays were also interviewed to determine how the tree farm data had been collected. Those tree farms discovered during field verification which had not been reported in the barangay-based inventory were then recorded on a barangay data sheet. Some municipal officials and barangay chairmen not included in the sample barangays were interviewed as key informants to investigate possible reasons that may have affected the response rate.

RATIONALE FOR A BARANGAY-BASED INVENTORY

Tree farming or farm forestry is prevalent in many Asian countries including the Philippines (FAO 2009). The bright economic prospects of tree farming have boosted people's interest in tree farming in the last decade (Dewees and Saxena 1997; Holding-Anyonge and Roshetko 2003). Inventory information on timber resources, including smallholder tree farms, is essential in management and planning (Vanclay 1992), and for formulating sound strategies for forestry development (Rawat *et al.* 2003). At the industry level, a timber inventory provides information on timber stock which is crucial in making decisions on timber harvest regulations and sustained yield. Most trees on farms are planted in small blocks, agroforestry and fenceline plantings, and trees are often fragmented in the landscapes. Most tree farms, however, could not qualify as 'forest' because of either size or spatial limitations set out in many technical forest definitions (e.g. FAO 2001, FAO 2005) and consequently this particular type of timber resource is not included in most national forest inventories (Klein 2003). In the Philippines, information about tree planting on private land is scarce. Government regulation requires that trees planted on private land be registered with the Department of Environment and Natural Resources (DENR) to document the extent of tree plantation on private land and to facilitate processing of document requirements during harvesting (Calub 2005). Tree registration is an excellent source of information relating to smallholder tree farming; however, only a relatively small proportion of smallholders register their trees (Cedamon *et al.* 2005).

The science of forest inventorying is well established, e.g. Chapman and Meyer (1949), Husch *et al.* (1972), Avery (1975) and Shiver and Borders (1996). Forest inventories are often carried out for large areas of plantations or natural forests with a relatively small number of owners with a focus on timber approaching harvest age. Obviously, because of smallholder tree farm characteristics − i.e. the land area is very small and trees are planted as agroforestry and fragmented in the landscape − conventional forest inventory techniques face major limitations and involve high cost. In addition, it has been pointed out that no comprehensive inventory approach has been developed yet that can be used to estimate available trees over large areas outside forests (FAO 2001). Consequently, trees outside forests have generally not been included in most national forest inventories (Klien 2003). Thus, an inventory method specifically designed to assess the status and extent of this important but diffuse timber resource on smallholder tree farms is required to be able to legislate sound policies and develop management programs that would support sustainable forest resource management as well as the timber industry.

In the Philippines, a barangay is the smallest unit of government which usually encompasses a number of districts or sitios. In many rural areas, a barangay may be composed of no more than 500 households. Barangays have their own sets of governing councils elected by the residents. The barangay council is headed by a chairman. The council members receive a monthly honorarium for their services. The barangay council collects census data about its constituents for program planning and development and obtaining government funding. If barangays are collecting timely census data about their constituents, it would be possible for the barangay chairman to provide the information relating to tree farms. This could be a simple and inexpensive way of determining the available timber resource on smallholder tree

farms in a particular area. Data such as names of tree farmers, number of trees planted, and tree age and species are simple yet essential information about the timber resource on smallholder tree farms that could be provided by laymen. Thus, the barangay-based inventory method could be an alternative method of assessing smallholder timber resources in large areas, i.e. barangay and municipality. The reliability of the barangay-based inventory of tree farms is assessed in the next section.

RELIABILITY OF BARANGAY-BASED TREE FARM INVENTORY

This section presents an analysis of the reliability of the barangay-based tree farm inventory based on a sample of 115 tree farmers. The response rate of the barangay chairmen to inventorying the smallholder tree farms is first discussed. Then the reliability of the number of tree farming households, and the number of trees and stands, are examined. The t-test is used to check for significant differences in the reported and verified number of trees and age per farming household. Using simple linear regression, the influence of the number of trees on the reliability of the reported number of trees is analysed. Lastly, the strategies employed by the barangay chairmen in collecting tree farm data are assessed.

Response Rate of Barangay Chairmen in Conducting Barangay-based Inventories

The response rate of the barangay chairmen in the seven municipalities in conducting barangay-based tree farm inventories was assessed. The total number of barangays in each municipality as well as the response rate is presented in Table 1. The response rates of the barangay chairmen range from 13% to 90%, and six out of the seven municipalities had a response rate of more than 50%. The average response rate across the seven municipalities was 67%. The low response rate of the barangay chairmen in Dulag was due to the unsuitability of tree farming in most of the barangays. Dulag is a flat, low lying municipality and its land is mainly used for agricultural crop production, e.g. rice, corn and coconuts, making tree farming a less favoured land use. The high response rate in Leyte Leyte was due to the influence of municipal agricultural technicians who put pressure on the barangay chairmen to do the inventory of the tree farms. Apparently, a 100% response rate was not possible because tree farming is not suitable in some barangays, e.g. barangays located in town centres or coastal or island barangays.

Table 1. Response rate of barangay chairmen in seven municipalities on Leyte Island in conducting barangay-based tree farm inventories

Municipality	Total number of barangays	Frequency of barangays with a tree farm inventory	Response rate (%)
Bato	31	27	87
Dulag	45	6	13
Hindang	20	10	50
Isabel	24	16	67
Leyte	30	27	90
Anahawan	14	11	79
Libagon	14	11	79

Reliability of Reported Number of Tree Farming Households

In the field verification that was conducted, tree farms not reported in the barangay-based inventory were recorded on a barangay data sheet to determine the reliability of the reported number of tree farming households. This field verification indicated there were 173 tree farmers in the study sites while 121 of them were reported in the barangay-based inventory

(Table 2). It is shown in Table 2 that the majority of the selected barangays have a 100% reliability while only a 40% reliability was observed for barangay 2. It is apparent from Table 2 that the reliability of the number of tree farmers observed in a barangay is directly related to the population of tree farmers present in that barangay. This result is not surprising because the greater the number of tree farmers covered in the barangay-based inventory the more the work load for the barangay chairmen.

Table 2. Reliability of the number of tree farmers per barangay

Barangay	Number of farming households reported	Number of farming households after field verification	Percentage reliability of the number of farming households (%)
1	47	62	76
2	23	57	40
3	5	5	100
4	3	3	100
5	19	22	86
6	3	3	100
7	4	4	100
8	5	5	100
9	7	7	100
10	5	5	100

Reliability of Number of Trees and Stand Age per Tree Farming Household

In examining the reliability of the number of trees (NoT), data for six of the tree farmers were removed because the NoT and stand age had not been obtained by the barangay chairmen after a request by these tree farmers to have their privacy protected. An additional 17 tree farmers for whom the calculated absolute difference in number of trees was more than 110 were removed from the data set because their values were too extreme for a sensible analysis of reliability of number of trees. The average number of trees grown by these 17 farmers was 734 and the average difference in number of trees was 543. Generally, these farmers operate the relatively larger tree farms.

The final data set used in the analysis of reliability of the number of trees consists of a sample of 98 tree farmers from the 10 selected barangays. The mean number of trees grown as indicated by field verification is 48.6 trees (standard error of the mean is 5.98). During the analysis, the reported NoT was first deducted from the verified NoT to determine the extent of over-reporting or under-reporting, then the relationship between NoT and size of the tree farm was examined through a regression analysis. The critical question addressed through the regression analysis was: 'Was the number of trees left out or over-reported in the barangay-based inventory influenced by the aggregate number of trees grown by tree farmer?' The reliability of the number of trees and stand age were then computed for each tree farmer. Data management and analysis were conducted using Excel.

It was found from the calculated difference on NoT that 52% of tree farmers had under-reported their NoT, while 33% had over-reported their NoT and 15% had the same NoT in both the reported and verified data. This distribution is apparent from Figure 1 in which observations lying above the x-axis represent tree farmers with an under-reported NoT and those below the x-axis are tree farmers with an over-reported NoT. The regression analysis conducted to determine the difference in number of trees and the verified NoT, showed that the aggregate of number of trees grown has a significant influence on the reliability of the barangay-based inventory. The slope coefficient of the regression model (Figure 1) was 0.271 (standard error .049, t=5.48, 97 df) and the intercept coefficient was -5.01 (standard error 3.78, t=-1,3250, 97 df), in which the slope coefficient is significant at the 95%

confidence level. The regression model shows that as the number of trees grown by a farmer increases, the number of trees not reported also increases, in other words, the reliability decreases. The slope coefficient indicates that all factors being held constant, there are 27(±1.96*.049) out of 100 trees that are not reported in the barangay-based inventory. To generalize this finding, the reliability of the number of trees in the barangay-based inventory is 72% which means that the number of trees is under-reported.

The average number of trees per farm reported in a barangay-based inventory is 40 while that in the verified data is 49. A t-test was conducted to test if there is significant difference in reported and verified number of trees. The null hypothesis tested was the reported number of trees (μ_1) in the barangay-based inventory is the same with the verified data (μ_2), i.e. *Ho*: $\mu_1 = \mu_2$. This was tested at the 5% significance level, with 194 dff, assuming equal variances. The computed test statistic is t=-1 (p = .31), which is not significant. The null hypothesis was accepted which lead to the conclusion that the sample data failed to prove that there is a difference between the reported and verified data. In terms of the reliability of the number of trees, the barangay-based inventory is judged to be highly reliable.

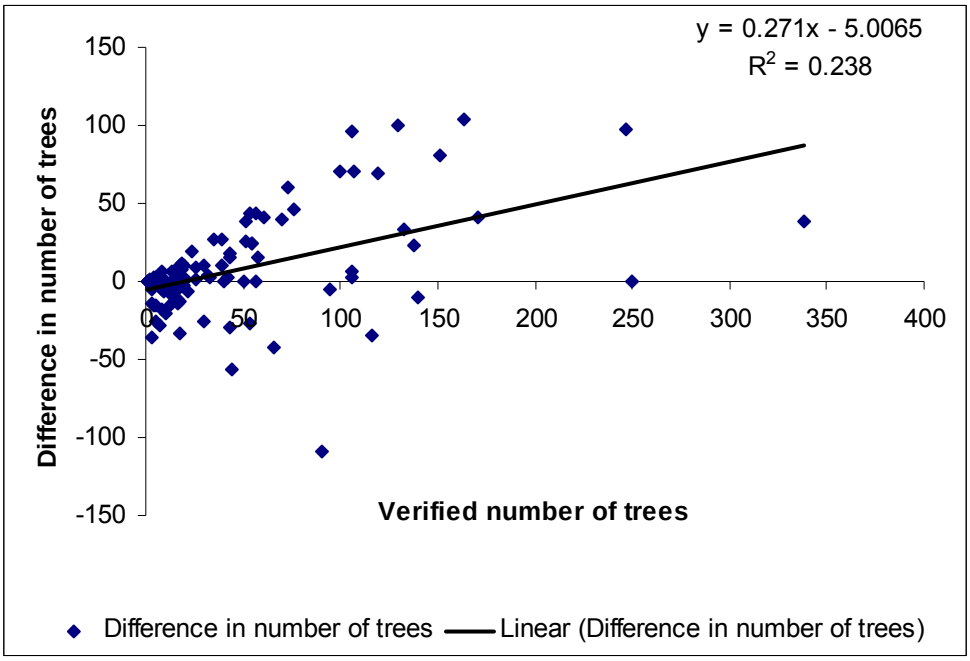

Figure 1. Scatter plot of difference in number of trees

The stand age of tree farms was also analysed. The data set used for the analysis of the reliability of stand age consisted of 115 tree farmers. The average stand age reported in the barangay-based inventory is 9.25, while the average stand age of the verified data is 9.01. The average difference in stand age is -.24 (±.29*1.96). A t-test was conducted to determine if there is a significant difference between the average stand age in the barangay-based inventory (μ_1) and in the verified data (μ_2). The null hypothesis is *Ho:* $\mu_1 = \mu_2$; that is, there is no difference in stand age between the two sets of data. The analysis was carried out with alpha .05 and d.f. of 228 assuming equal variances. The computed t statistic is 0.25 (p=0.8) which is not significant at the .5% level, i.e. there is no significant difference between reported and verified stand age. This analysis, therefore, confirmed that the stand age reported in the barangay-based inventories is reliable.

With regard to species identified by barangay chairmen in their reported tree farm data, it was observed that most barangay chairmen reported the 'local names' of species although some species were identified by their common names. Local names are names used in that

municipality only, whereas common names are the accepted names used by foresters in identifying trees. Obviously, local names of species vary with differences in dialects, e.g. a Waray-speaking area would have a different local name than a Cebuano speaking municipality. A typical example for this is Molave (*Vitex parviflora*), which is known as 'hamorawon' in Waray areas while it is called 'tugas' in Cebuano. It was found that barangay chairmen had reported the correct names of the tree species grown.

The chairmen of the 10 barangays included in the study were interviewed to determine how they had gathered the tree farm information for each tree farming household. Their strategies, along with associated reliability of the number of trees and stand age, are reported in Table 4. There were six strategies used by barangay chairmen in gathering tree farm information. In interpreting the values in this table, figures closest to 100 are considered the most reliable. It is apparent from Table 4 that strategy 5 which involves verification by barangay chairmen of the council tree farm data[4] through actual field inspection of tree farms and interviewing farm owners, yielded the highest reliability rating. Inventories based solely on interviews with tree farmers (strategy 4) yielded a relatively low reliability.

Table 3. Mean percentage of reliability of number of trees and stand age according to strategies used by barangay chairmen to gather tree farm data

Strategy used to gather farm data	Mean reliability of number of trees (%)	Mean reliability of stand age estimate (%)
(1) Chairmen and barangay council members did the inspection of tree farms and interview with tree farmers	126.48	144.49
(2) Council member reports were verified by the chairmen through interviews with barangay tanod[5] and sitio[6] leaders	75.90	153.57
(3) Households reported to have trees planted were visited by the chairman and council member and interviewed to estimate number of trees, age and species identified	131.71	118.07
(4) Tree farmers were interviewed by the chairmen to estimate tree farm data	47.57	68.91
(5) Barangay council tree farm data were verified by the chairmen through actual inspection of tree farms and interview with farm owners	103.96	108.25
(6) Chairmen visited tree farmers and the number of trees and age were estimated by both the chairmen and farmers	107.34	71.21

A number of important findings are highlighted in the evaluation of the reliability of the barangay-based inventory of smallholder tree farms. First, the number of households which grew trees in the barangay is highly reliable with a reliability rating of about 90%. Statistical tests showed that there is no significant difference in the number of trees and stand age between the barangay chairmen's inventories and those found during the field verification. The reliability rating of the number of trees for the majority of tree farmers reported, is 72%. In addition, a regression analysis showed that the reliability of the reported number of trees

[4] According to the barangay chairmen who used this strategy, the barangay council tree farm data had been generated from reports by sitio or zone leaders. These data were then verified by the barangay chairmen.

[5] A barangay *tanod* is a deputized civilian in the barangay acting as a local police officer.

[6] A *sitio* refers to a specific zone in the barangay comprised of not less than 10 households.

is negatively related to the relative size of the tree farms. This indicates that measures should be put in place to minimize error in inventorying larger-scale tree farms for barangay-based inventories. The reliability of stand age reported in the barangay-based inventory is ± 0.24 year difference to the 'correct' age which was found to be non-significant. The barangay-based inventory strategy that involved the 'verification by barangay chairmen of the council report on tree farming by actual field inspections plus interviews with farm owners' yielded the highest reliability rating.

POTENTIAL ROLE OF BARANGAY CHAIRMEN IN TREE REGISTRATION

Registration of trees planted by private individuals on private land is encouraged by the Philippines Government to provide farmers tenure over trees. Registration of trees facilitates the approval of harvest and transport permits. However, the current tree registration is found to be unfavourable to farmers because it often involves a high cost due to the fact that they have to travel[7] to Community Environment and Natural Resources Offices (CENROs) and are required to make payments to CENRO staff conducting the tree inventory. The tree registration process requires CENRO staff to conduct field inspections to tally the number of trees by species for which a registration application is made, and prepare a sketch map of the tree farm site (Calub 2005). Anecdotal evidence suggests that tree registration takes a long time – sometimes up to a year before a tree registration certificate is approved – because of the delay in the inspection of the tree plantation. In the tree registration process, devolving some responsibilities to barangay councils is seen to be an effective measure to help tree farmers reduce the cost of registering their trees. Because the barangay-based inventory is highly reliable in terms of reporting the number of trees, stand age and local names of species, barangay chairmen could conduct the inventory and produce records of tree plantations or tree farms. The barangay chairmen could then certify the tree plantation records and submit this to the CENRO for issuance of the certificate of registration. Certification from the municipal mayor may be required to provide a third party certification. Perhaps barangay councils could charge lower fees for conducting the inventories and certification but measures should be put in place so that the fees charged by barangay councils to applicants for tree registration are reasonable. This may require further investigation into appropriate charges for inventory and certification that should be collected by barangay chairmen. This proposed tree registration scheme promises a significant reduction in the cost of the registration of trees and in the waiting period for approval of a tree registration certificate. An intergovernmental agency consultation meeting may be necessary to institutionalize the involvement of a barangay-based inventory in the tree registration process.

IMPLICATIONS OF THE RELIABILITY OF BARANGAY-BASED INVENTORIES FOR SMALLHOLDER FORESTRY RESEARCH

A market modelling study for smallholder timber on Leyte Island, the Philippines is being conducted by the first author. This market modelling study is investigating the optimal location for the processing and marketing of sawn timber from smallholder tree farms on the island. The economic impact of pruning and thinning on smallholder farms is also being assessed. The model is formulated as a transhipment model and specifies timber supply as one of the model constraints. In the transhipment model, available timber supply, particularly for relatively small tree farms, is being determined for each municipality based on the barangay inventory. The number of trees reported in the barangay-based inventory is adjusted for error using the regression model presented above. Some statistical

[7] There are five CENROS on Leyte Island. CENRO Maasin and Palo each have sub-stations in one of the municipalities in their respective jurisdiction. These offices receive and process applications for tree registration.

manipulation is being used to predict the aggregate volume of timber on the island available for sawn timber processing.

In many areas in the Philippines, and also in other developing countries in Asia, records of smallholder tree farmers are not available from government or non-government agencies, with the result that obtaining sampling frames for research projects conducted in this sector is difficult. Where village leaders are cooperative in drawing up such a list, a village or barangay-based inventory could be helpful for creating a sampling frame.

MARKET INFORMATION AND FARM FORESTRY ACCOUNTING SYSTEMS BASED ON THE BARANGAY-BASED INVENTORY

Understanding the socio-economic performance of smallholder tree farming is crucial for developing support measures for tree farmers. However, because of a lack of information about smallholder forest enterprises on Leyte Island, and in the Philippines in general, accounting systems are necessary. Timely information concerning the status of timber resources on smallholder tree farms is also necessary to assist market actors in making investment decisions. However, current and reliable data that can be used to estimate timber supply from large-area smallholder tree farms are often not available.

Farm forestry accountancy networks have been developed in many advanced countries in Europe and the USA. Information generated by the farm forestry accountancy networks is required by farmers, forest owners associations, forest advisory and extension organizations, and policy-making and financing institutions, as well as for research and education (Niskanen and Thomas 2001). Forest accountancy network information is gathered from farm forestry enterprises or selected tree farms using various sampling techniques (Hyttinen and Kallio 2001). Sample farms are either monitored continuously or over several accounting periods. The type of information collected from these sample tree farms varies between networks but the aim is primarily to assess the profitability of farm forestry as well as the impact of changes in the economic and political environment at the farm level.

To the knowledge of the authors, no accountancy networks that gather formation on farm forestry accounts are as yet operating in the Philippines. The role of barangay chairmen in providing a reliable tree farm inventory has shown some bright prospects for developing a farm forestry accountancy network in the Philippines. However, this requires further investigation as to how farm forestry accountancy networks will operate, how sampling should be done and what information is required.

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